Attorney Docket: Shaffer-207

SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN that we, David Martin and Ronald Yater, have invented new and useful improvements in a

Subsea Coiled Tubing Injector with Pressure Compensated Drive System

of which the following is a specification:

CERTIFICATE OF EXPRESS MAILING

I hereby certify that this correspondence and all referenced enclosures are being deposited by me with the United States Postal Service as Express Mail with Receipt No. EV119110456US an envelope addressed to the Assistant Commissioner of Patents, BOX PATENT APP., Washington, DC 20231 on December 12, 2002.

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Subsea Coiled Tubing Injector with Pressure Compensated Drive System

Field of the Invention

The present invention relates to a subsea coiled tubing injector and, more particularly, to a subsea injector with a pressure compensated drive system.

Background of the Invention

Coiled tubing has been used for decades in land-based hydrocarbon recovery operations to perform various well treatment, stimulation, injection, or recovery functions more efficiently than threaded tubulars. In a conventional land-based operation, the coiled tubing injector may utilize a gear drive mechanism with conventional bearing assemblies to reliably and efficiently transmit power to the coiled tubing.

While conventional coil tubing injector may work satisfactorily for a land-based or a relatively shallow water hydrocarbon recovery operation, the conventional injector cannot work in a moderate or deep water operation because the drive mechanism for the injector is not sufficiently protected from the subsea environment. According to one proposal, the tubing injector is protected subsea by an enclosure, with seals provided between the enclosure and the coiled tubing above and below the injector. An example of this system is disclosed in U.S. Patent 4,899,823.

Conventional pipeline practice involves the launching of pigs to perform maintenance operations on pipelines. A pigging loop provides a closed circuit for the pigs to be launched and retrieved. Pigging is typically done to remove debris, such as paraffin or sand, which restricts the flow of production. A significant drawback to conventional pipeline techniques is the additional capital cost of the pigging loop, and the likelihood pigs getting stuck in the pipeline.

Brief Description of the Drawings

Figure 1 is a front view of a coiled tubing injector according to the present invention with opposing chains.

Figure 2 is a side view of the injector shown in Figure 1.

Figure 3 is a picture view of a suitable pressure compensating system shown in Figure 1.

Figure 4 is an enlarged view of the traction system of the injector shown in Figure 1.

Figure 5 illustrates rollers mounted on the carrier of opposing gripper blocks so that the chain link members move relative to the rollers.

Detailed Description of Preferred Embodiments

A coiled tubing injector 10 is provided for functioning in a subsea environment. An exemplary injector 10 according to the invention utilizes a traction assembly 12 as shown in Figure 1 to engage the coiled tubing and thereby drive the coiled tubing into or out of the well. A typical traction device comprises opposing grippers 14 that move laterally with respect to the tubular, thereby pressing the chain link members 16 moving in an endless loop into gripping engagement with the tubing. Each chain link member 16 thus moves longitudinally with respect to the stationary grippers 14 to move the tubing with respect to the tubing injector.

Roller bearings 20 as shown in Figure 4 provided on the chain link members 16 allow for a large lateral load to be applied from the grippers to the longitudinally moving chain links, preferably without inducing a significant longitudinal drag load. For the embodiment as shown in Figures 1 and 2, the rollers 20 as shown in Figure 4 are attached to the chain link segments 16 and thus ride on the base or skate of the gripper 14. For an alternate design, the rollers 20 may be located in a carrier supported the gripper blocks, so that the chain link members 16 move relative to the rollers 20. The fluid powered or electrically powered drive motor 11 rotates the links of each endless loop chain.

Bearing assemblies 52 as shown in Figure 1 and the injector gear case 54 preferably are both sealed to prevent sea water intrusion. The outboard bearing assemblies 52 guide the endless loop chain with respect to the body 58 of the injector. The gear case 54 transmits energy from the drive motor 11 to the endless loop chain using a plurality of gears housed within the gear box.

A pressure compensating device 60 as shown in Figure 3 is provided for compensating pressure within each outboard bearing assembly and within the injector gear case, and preferably to all components of the injector which are sensitive to pressure differentials. Conventional tubing or other conduit 62 may be used to interconnect the pressure compensating device 60 with the bearing assemblies 52, with the gear case 54, and with other pressure compensated components. The compensating device 60 may include a compensator housing 64 attachable to the injector housing, and a piston or a diagram within the housing 64 for separating the lubricant from substantially subsea fluid pressure. Air space in the gear case 54 of the drive unit and in the outboard bearing assemblies 52 may be evacuated with fluid lubricant prior to deployment.

The pressure compensator 60 is designed to balance the internal pressure of fluid in the gear case 54, the bearing assemblies 52, and other components which are plumbed back to the compensator 60. The compensator 20 thus allows for these components to experience only a selected pressure differential that may be slightly above, equal to, or slightly below the pressure of the sea water surrounding the injector.

An alternative design may provide a pressure compensation device, such as a piston or a diaphragm, in a bore in the shaft of each outboard bearing assembly 52. A seal on the piston may isolate the lubricant from subsea conditions. One face of the piston is exposed to lubricant and an opposing face to subsea conditions. A spring may exert a selected bias on the piston. For compensation within the gear case, it is a particular benefit that the compensator device to be structurally separate from the gear case housing, then plumbed to the interior of the

gear case.

The coiled tubing injector of this invention may also be used to perform pipeline maintenance operations. The pipeline version of the coiled tubing injector may be landed on the seabed and attached to an access valve in the pipeline using a lightweight connector. The pressure control system may consist of a gate valve, a shear ram, and a set of strippers. Tools and/or fluid may then be conveyed in and out of the pipeline using the coiled tubing. Because the coiled tubing may be used to pull the tools back from where they were launched, there is no need for a pigging loop. The use of coiled tubing also allows various fluids to be pumped into the pipeline, which would be especially beneficial for removing sand or paraffin.